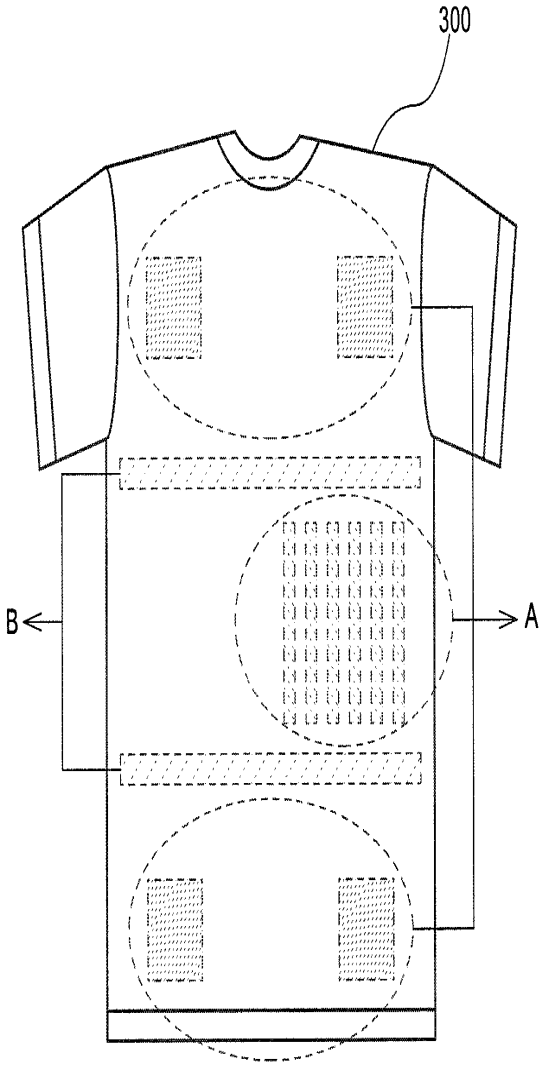
FIG.1



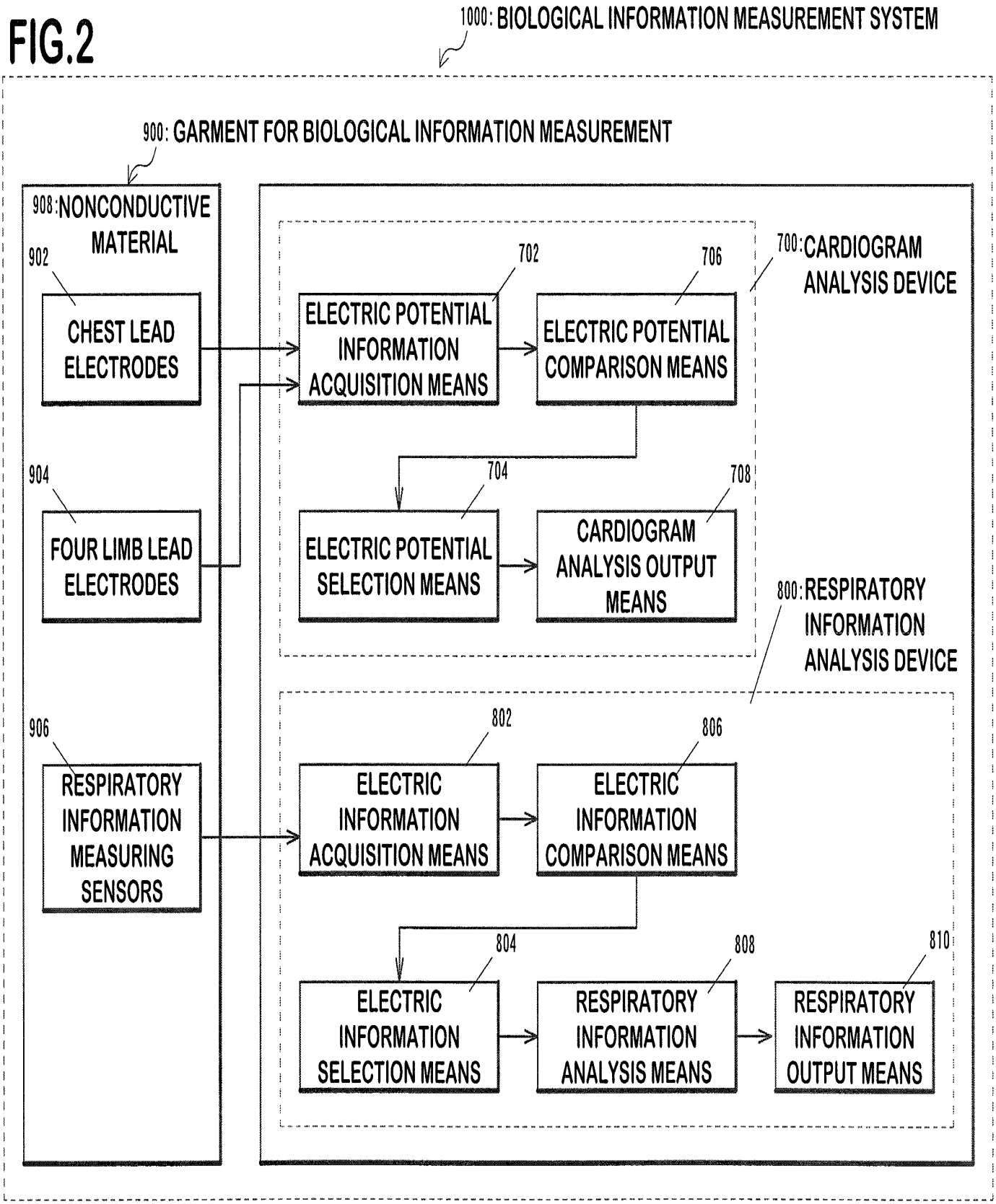
A ⇨ FIRST EMBODIMENT:
CARDIOGRAM MEASUREMENT

SECOND EMBODIMENT:
CARDIOGRAM MEASUREMENT PROCESSING

B ⇨ THIRD EMBODIMENT:
RESPIRATION RATE MEASUREMENT PROCESSING

A+B ⇨ FOURTH EMBODIMENT:
RESPIRATION RATE MEASUREMENT PROCESSING
(IN COMBINATION WITH CARDIOGRAM R-WAVE ANALYSIS)

FIG.2


1000: BIOLOGICAL INFORMATION MEASUREMENT SYSTEM
900: GARMENT FOR BIOLOGICAL INFORMATION MEASUREMENT
908: NONCONDUCTIVE MATERIAL
902
CHEST LEAD ELECTRODES
904
FOUR LIMB LEAD ELECTRODES
906
RESPIRATORY INFORMATION MEASURING SENSORS
700: CARDIOGRAM ANALYSIS DEVICE
702
ELECTRIC POTENTIAL INFORMATION ACQUISITION MEANS
706
ELECTRIC POTENTIAL COMPARISON MEANS
704
ELECTRIC POTENTIAL SELECTION MEANS
708
CARDIOGRAM ANALYSIS OUTPUT MEANS
800: RESPIRATORY INFORMATION ANALYSIS DEVICE
802
ELECTRIC INFORMATION ACQUISITION MEANS
806
ELECTRIC INFORMATION COMPARISON MEANS
804
ELECTRIC INFORMATION SELECTION MEANS
808
RESPIRATORY INFORMATION ANALYSIS MEANS
810
RESPIRATORY INFORMATION OUTPUT MEANS

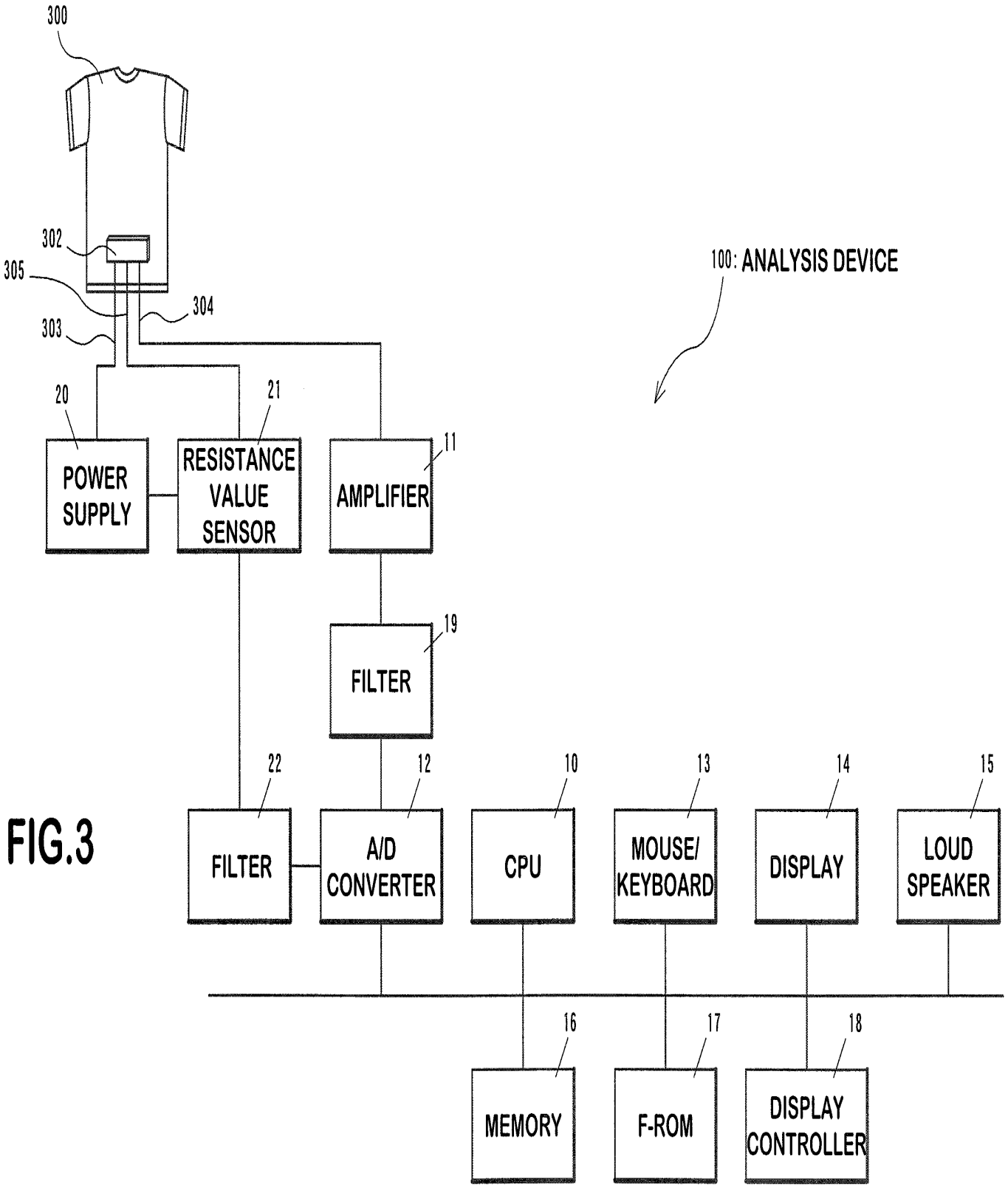

300
302
305
304
303
100: ANALYSIS DEVICE
20
21
11
POWER SUPPLY
RESISTANCE VALUE SENSOR
AMPLIFIER
19
FILTER
22
12
10
13
14
15
FILTER
A/D CONVERTER
CPU
MOUSE/ KEYBOARD
DISPLAY
LOUD SPEAKER
16
17
18
MEMORY
F-ROM
DISPLAY CONTROLLER

FIG.3

FIG.4A

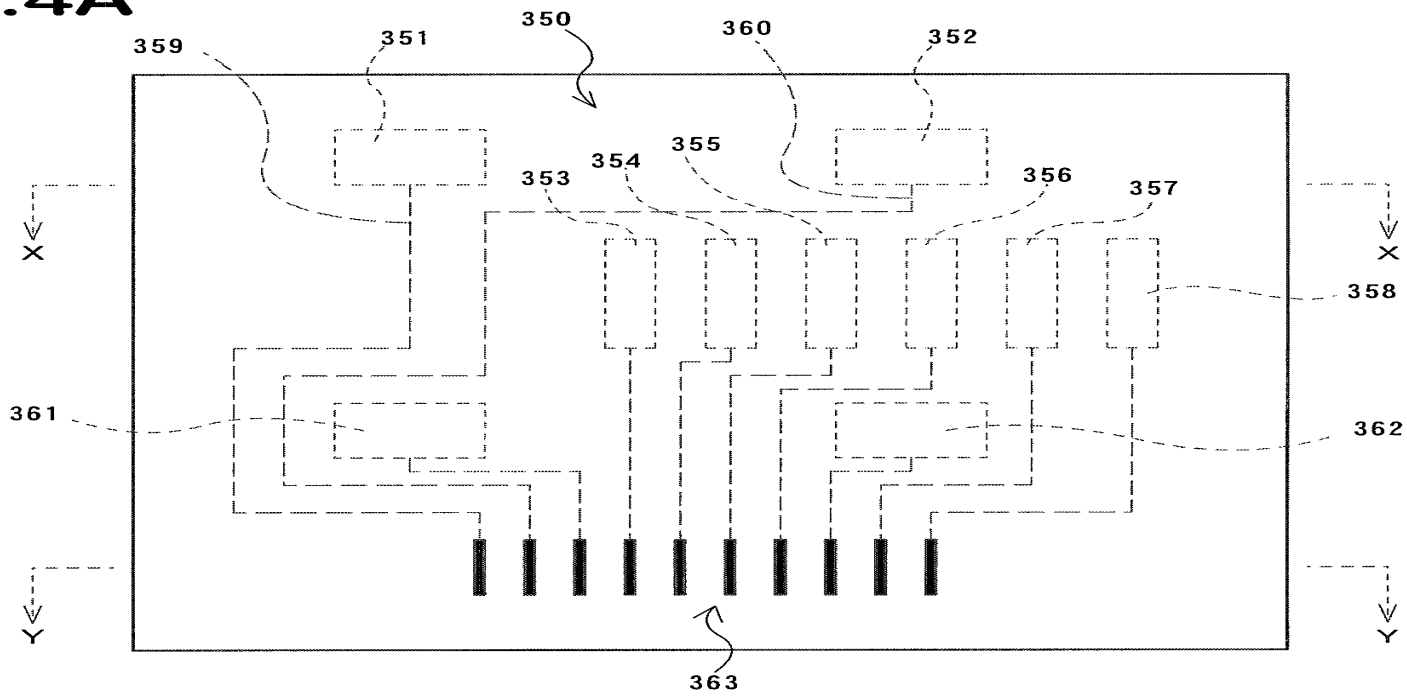


FIG.4B

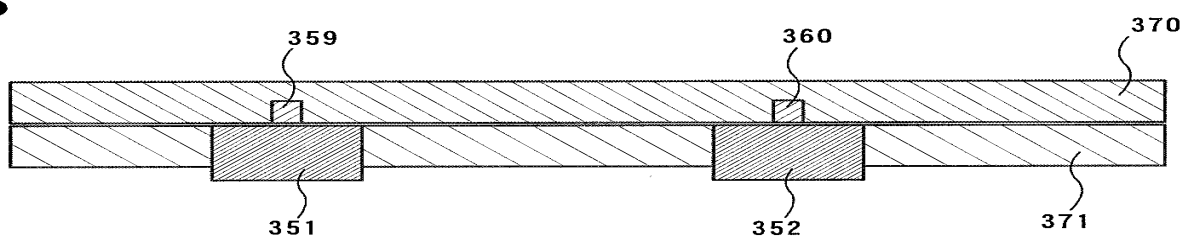


FIG.4C

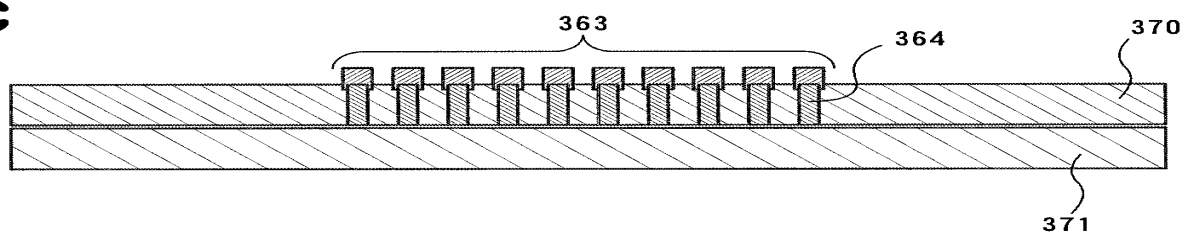


FIG.5A

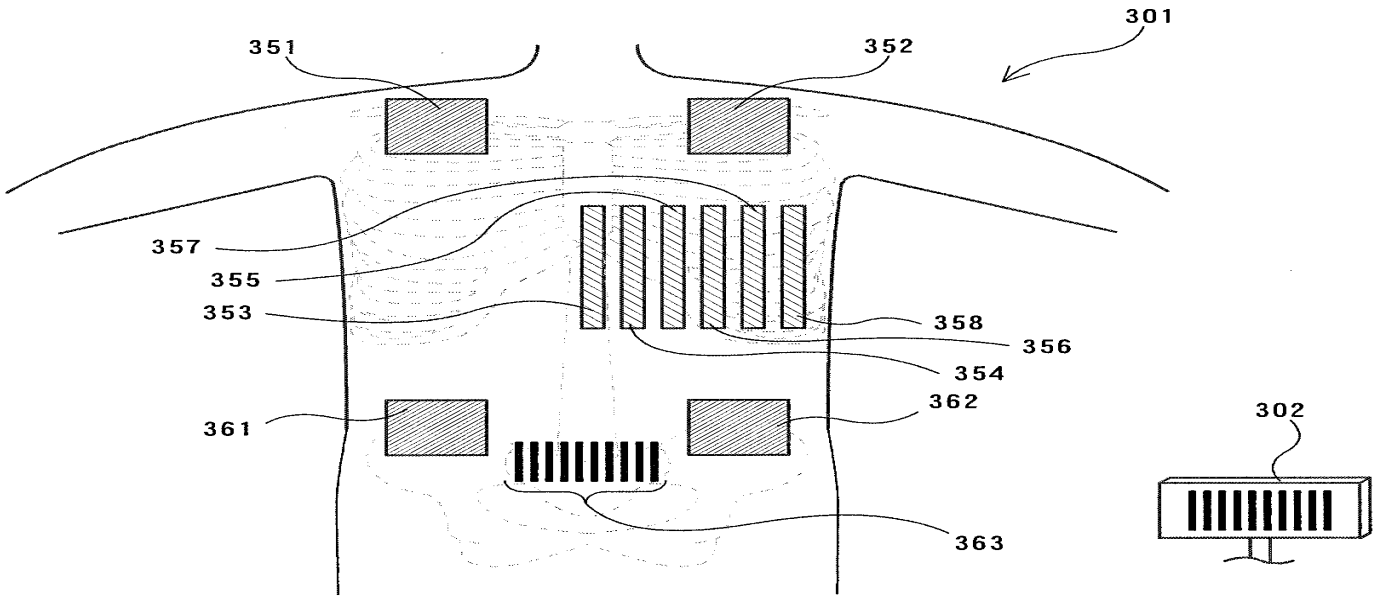

301
351
352
357
355
353
358
356
354
361
362
363
302

FIG.5B

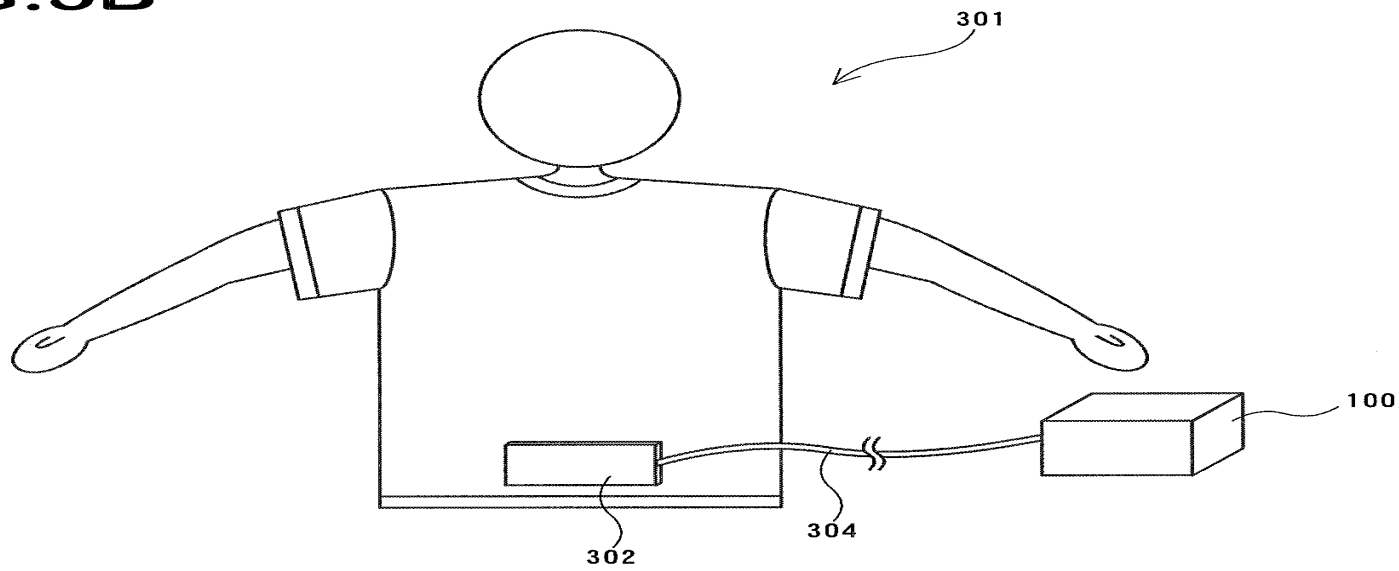

301
100
304
302

FIG.6

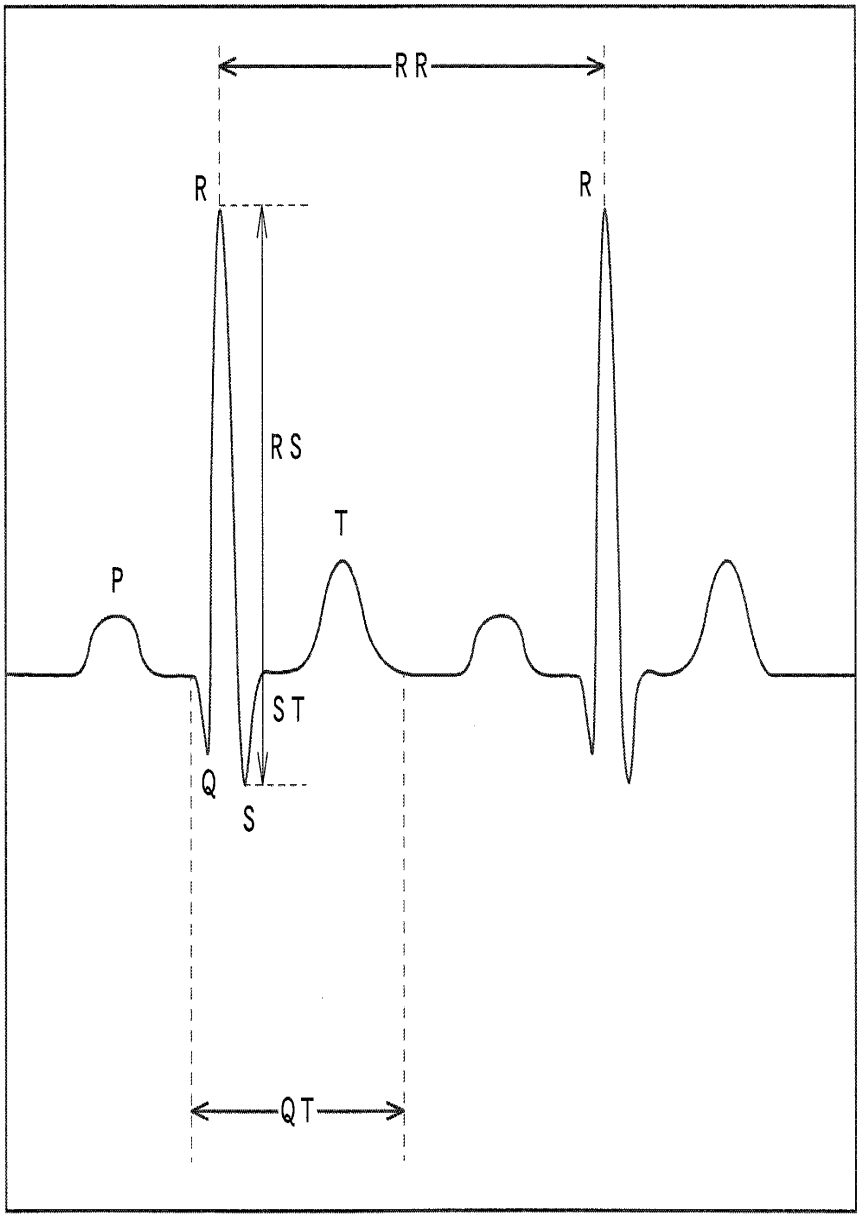


FIG.7

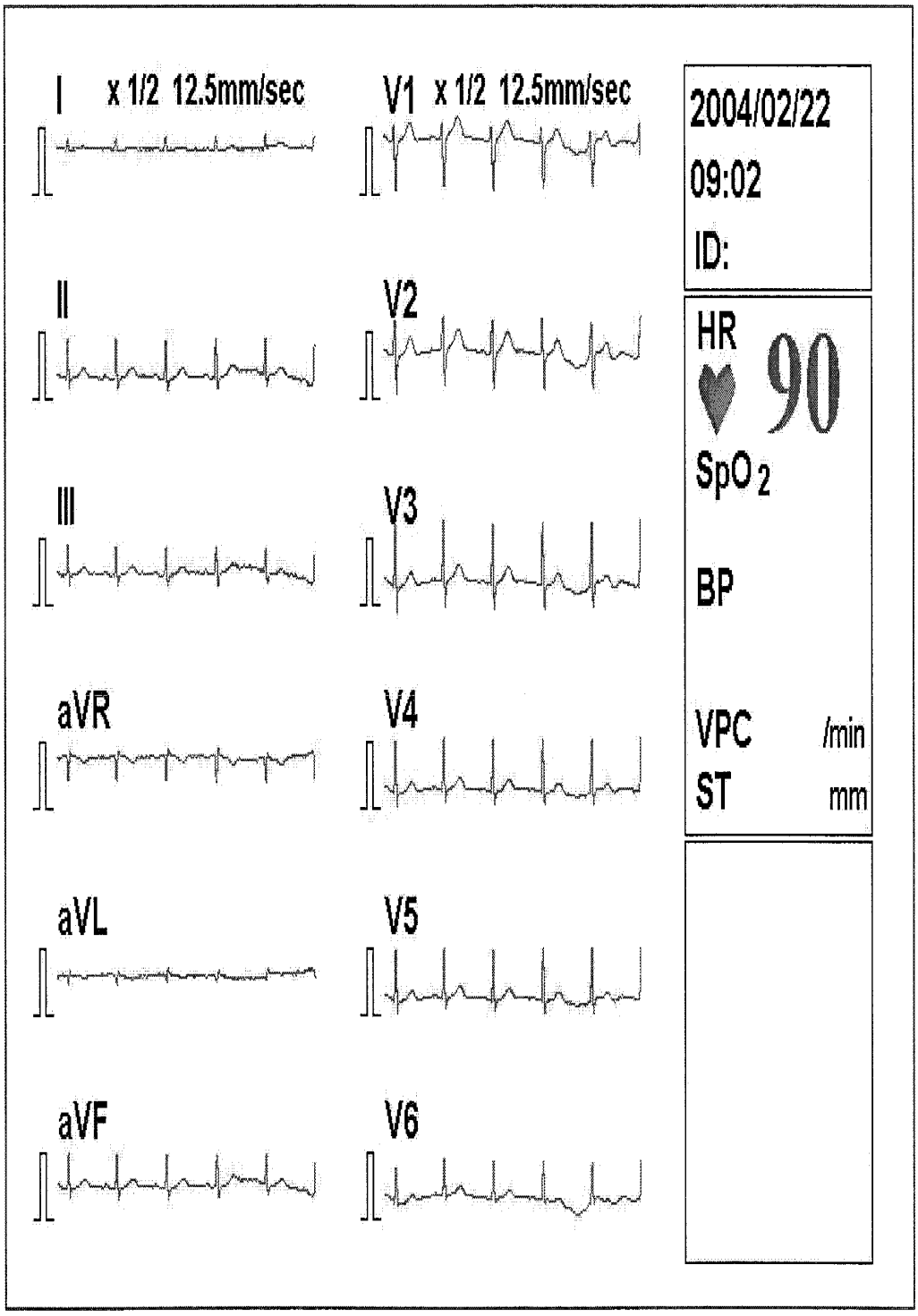

I x 1/2 12.5mm/sec
V1 x 1/2 12.5mm/sec
II
V2
III
V3
aVR
V4
aVL
V5
aVF
V6
2004/02/22
09:02
ID:
HR
90
SpO2
BP
VPC /min
ST mm

FIG.8A

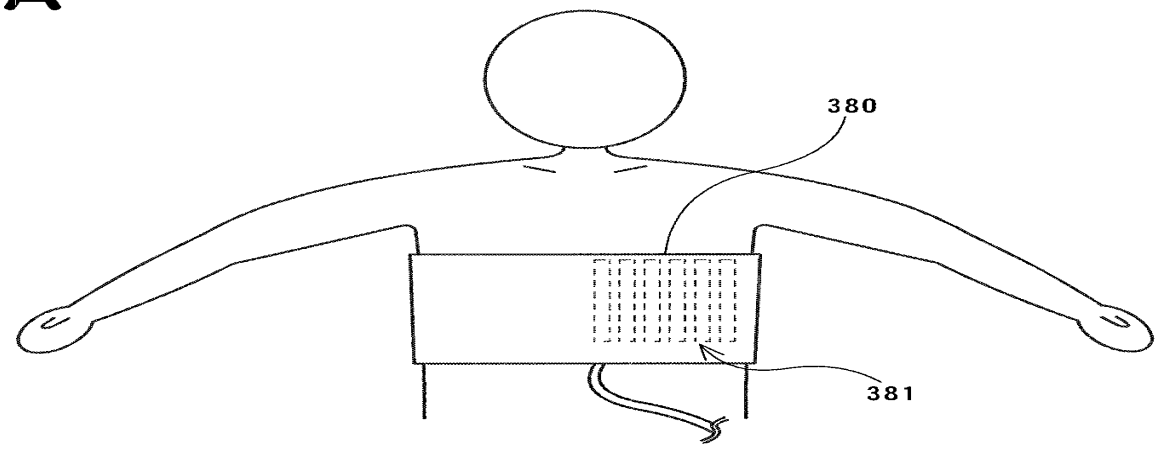


FIG.8B

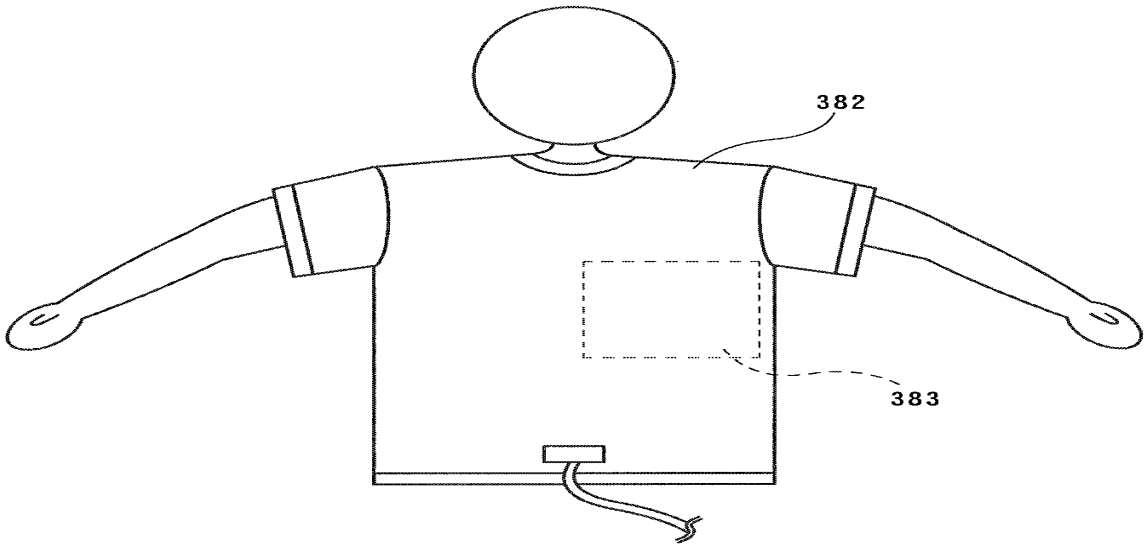


FIG.9

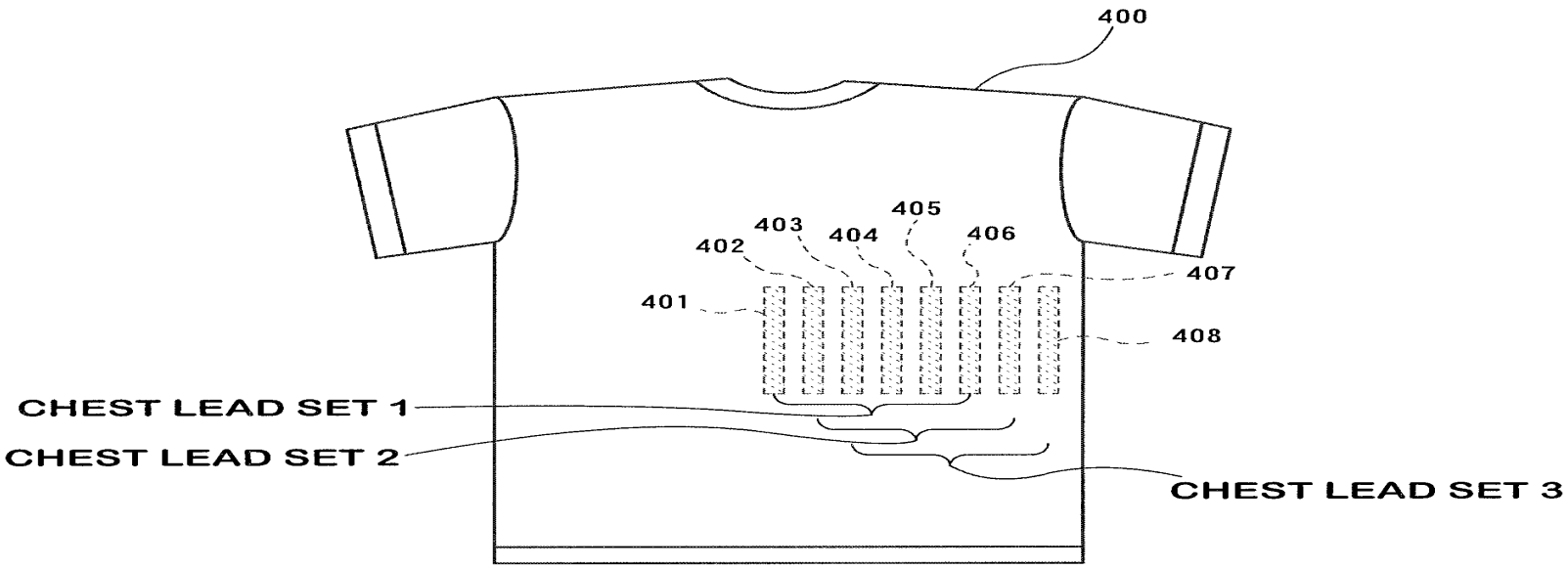

400
403
405
402
404
406
407
401
408
CHEST LEAD SET 1
CHEST LEAD SET 2
CHEST LEAD SET 3

FIG.10

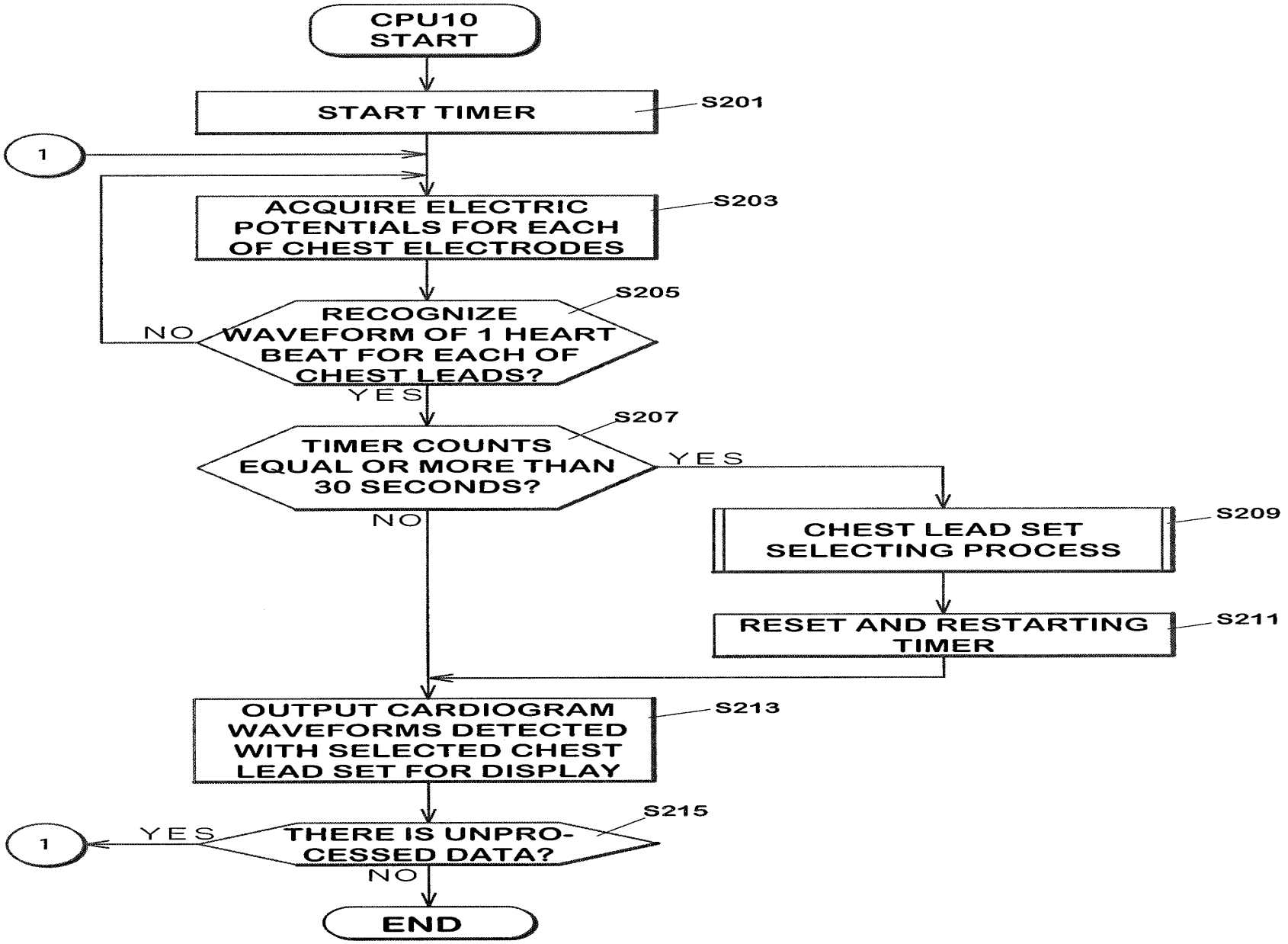

CPU10
START
START TIMER
S201
1
ACQUIRE ELECTRIC POTENTIALS FOR EACH OF CHEST ELECTRODES
S203
RECOGNIZE WAVEFORM OF 1 HEART BEAT FOR EACH OF CHEST LEADS?
S205
NO
YES
TIMER COUNTS EQUAL OR MORE THAN 30 SECONDS?
S207
YES
NO
CHEST LEAD SET SELECTING PROCESS
S209
RESET AND RESTARTING TIMER
S211
OUTPUT CARDIOGRAM WAVEFORMS DETECTED WITH SELECTED CHEST LEAD SET FOR DISPLAY
S213
THERE IS UNPRO-CESSED DATA?
S215
1
YES
NO
END

FIG.11

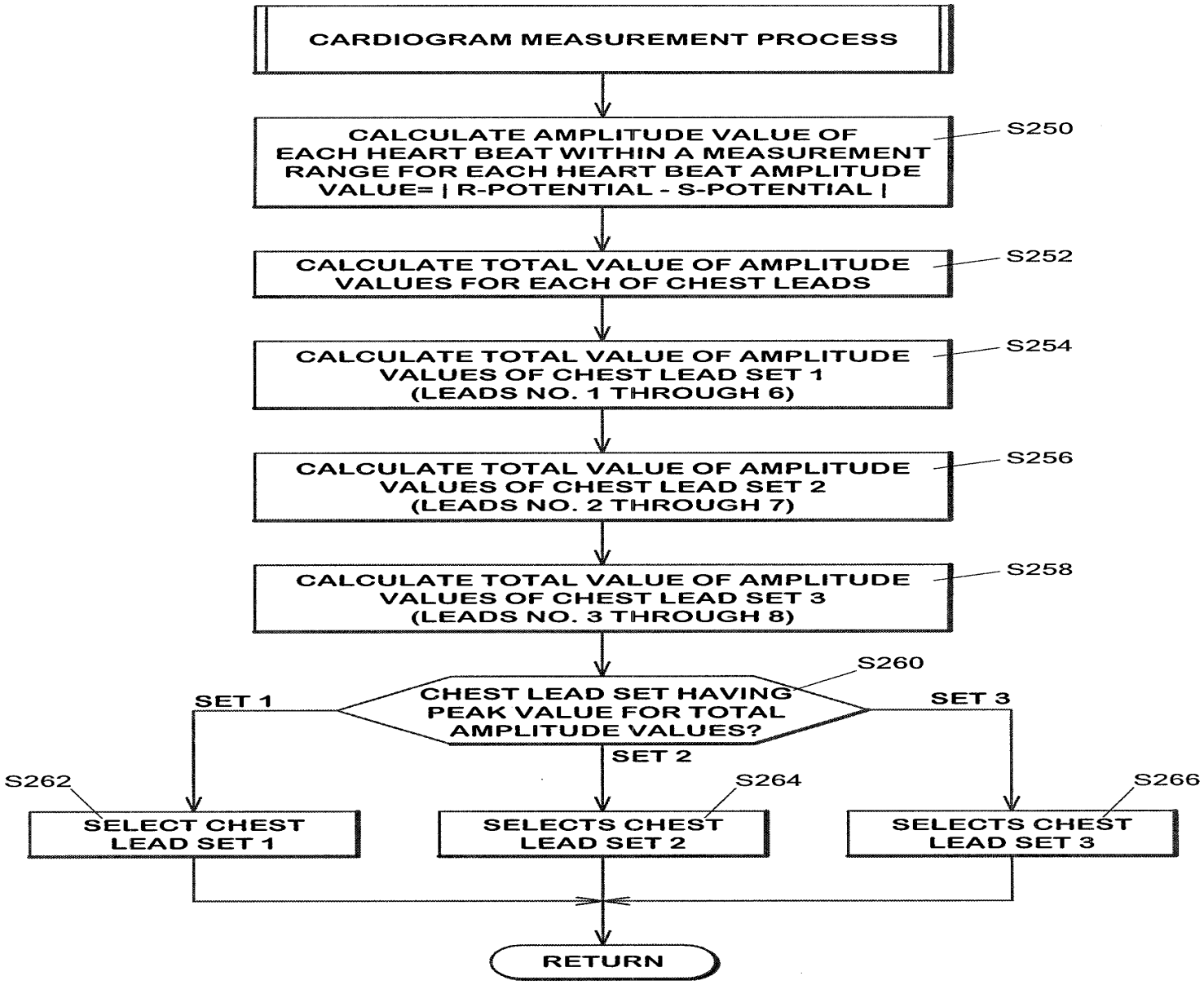

CARDIOGRAM MEASUREMENT PROCESS
CALCULATE AMPLITUDE VALUE OF EACH HEART BEAT WITHIN A MEASUREMENT RANGE FOR EACH HEART BEAT AMPLITUDE VALUE= | R-POTENTIAL - S-POTENTIAL |
S250
CALCULATE TOTAL VALUE OF AMPLITUDE VALUES FOR EACH OF CHEST LEADS
S252
CALCULATE TOTAL VALUE OF AMPLITUDE VALUES OF CHEST LEAD SET 1 (LEADS NO. 1 THROUGH 6)
S254
CALCULATE TOTAL VALUE OF AMPLITUDE VALUES OF CHEST LEAD SET 2 (LEADS NO. 2 THROUGH 7)
S256
CALCULATE TOTAL VALUE OF AMPLITUDE VALUES OF CHEST LEAD SET 3 (LEADS NO. 3 THROUGH 8)
S258
CHEST LEAD SET HAVING PEAK VALUE FOR TOTAL AMPLITUDE VALUES?
S260
SET 1
SET 2
SET 3
SELECT CHEST LEAD SET 1
S262
SELECTS CHEST LEAD SET 2
S264
SELECTS CHEST LEAD SET 3
S266
RETURN

FIG.12A

450

	RS AMPLITUDE VALUE(mV)							
Data No.	CHEST LEAD No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8
1501	0.05	0.51	0.68	0.55	0.85	0.68	0.56	0.35
1502	0.09	0.58	0.72	0.54	0.81	0.59	0.48	0.21
1503	0.12	0.61	0.71	0.56	0.79	0.49	0.58	0.20
1504	0.08	0.61	0.65	0.54	0.78	0.42	0.49	0.58
1504	0.12	0.59	0.72	0.55	0.81	0.51	0.48	0.19
1530	0.11	0.59	0.71	0.66	0.79	0.54	0.48	0.18

FIG.12B

452

	TOTAL OF RS AMPLITUDE VALUES(mV)							
Data No.	CHEST LEAD No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8
1501-1530	2.85	17.45	20.95	17.00	24.15	16.15	15.35	8.55

FIG.12C

454

	TOTAL OF RS AMPLITUDE VALUES(mV)		
Data No.	CHEST LEAD SET 1 (LEADS No. 1 THROUGH 6)	CHEST LEAD SET 2 (LEADS No. 2 THROUGH 7)	CHEST LEAD SET 2 (LEADS No. 3 THROUGH 8)
1501-1530	98.55	111.05	102.15

FIG.13A

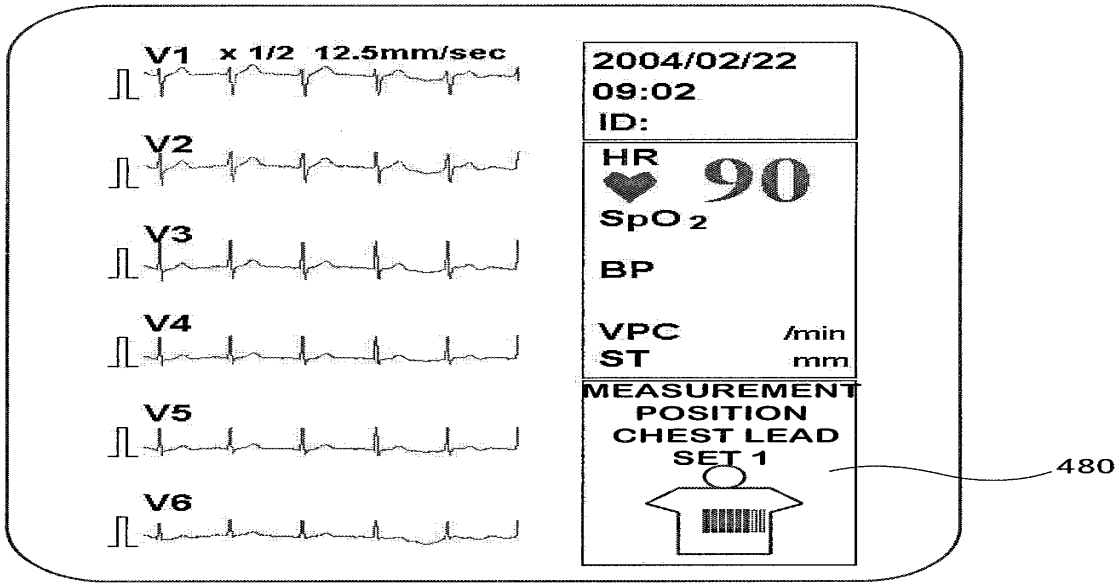


FIG.13B

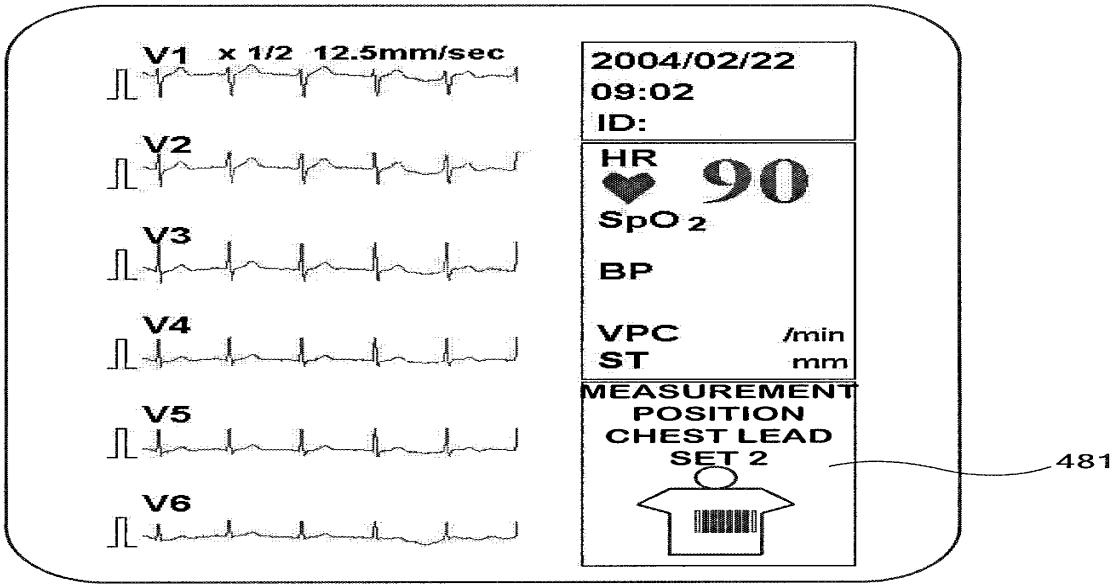


FIG.14

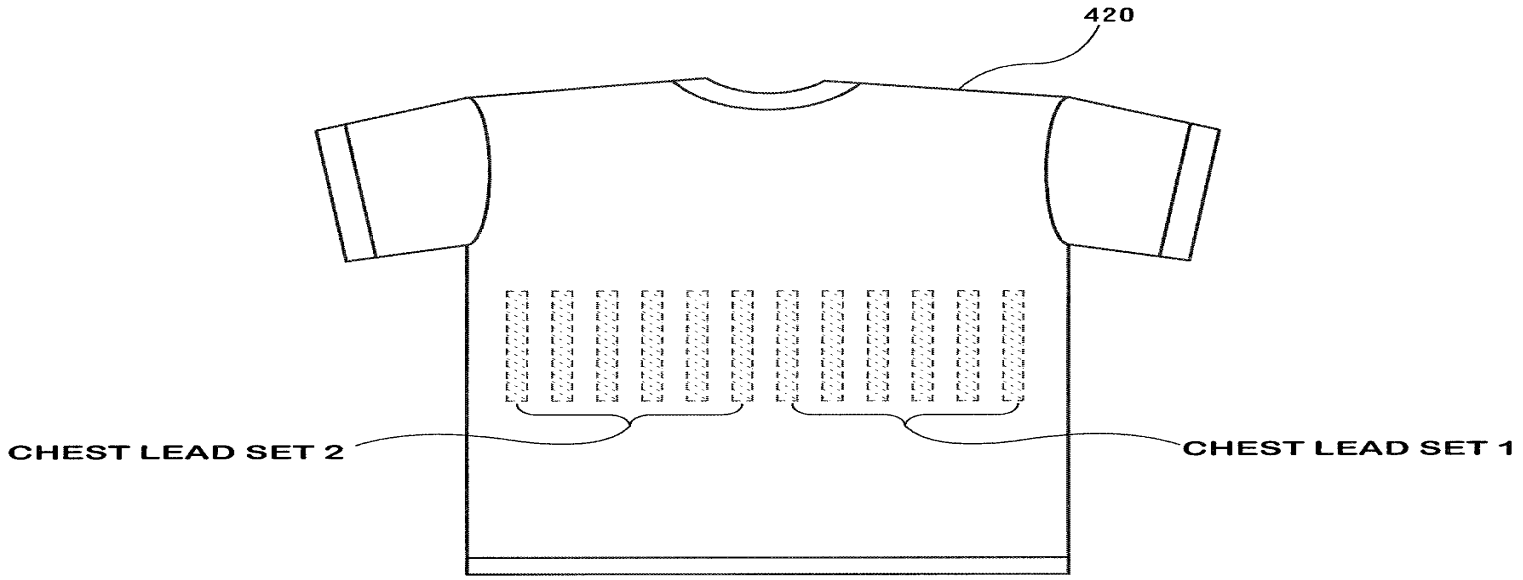


FIG.15A

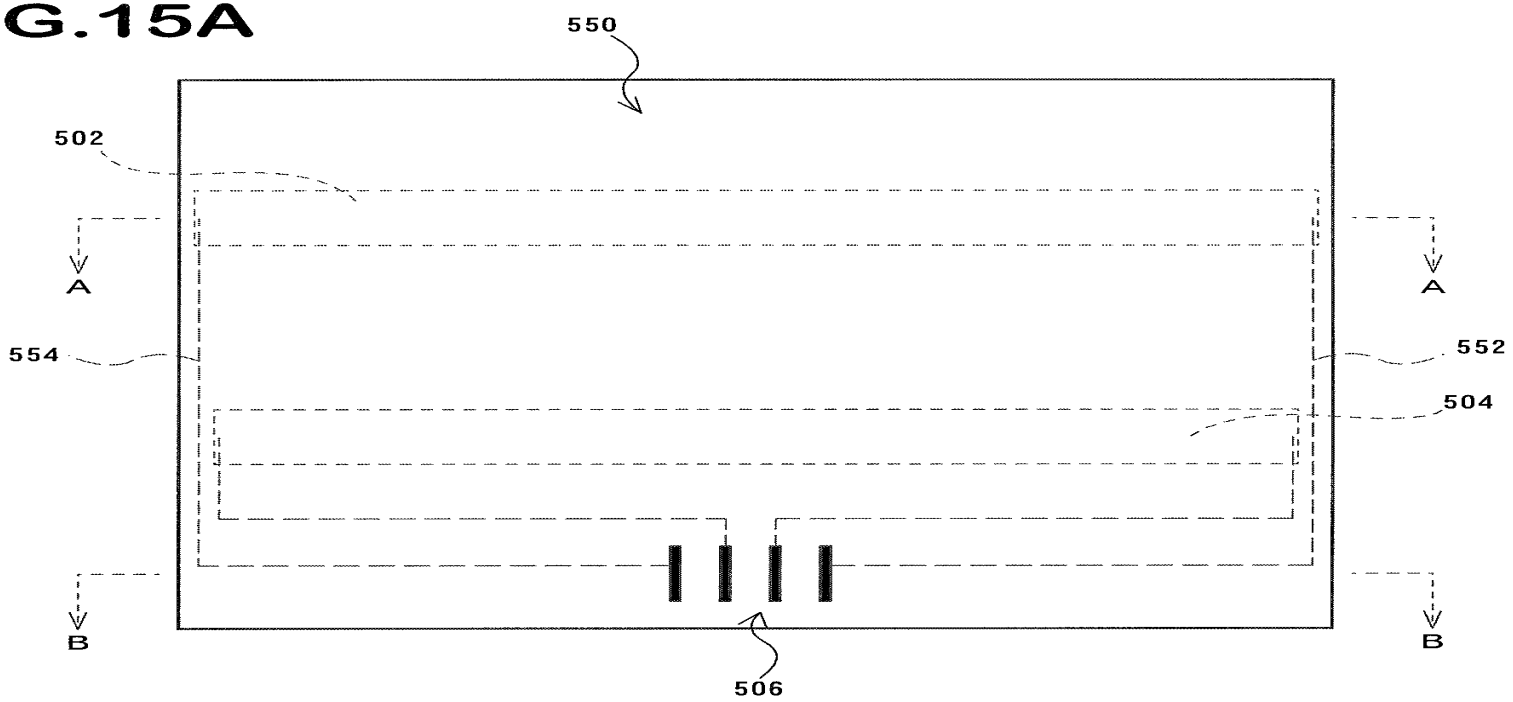


FIG.15B

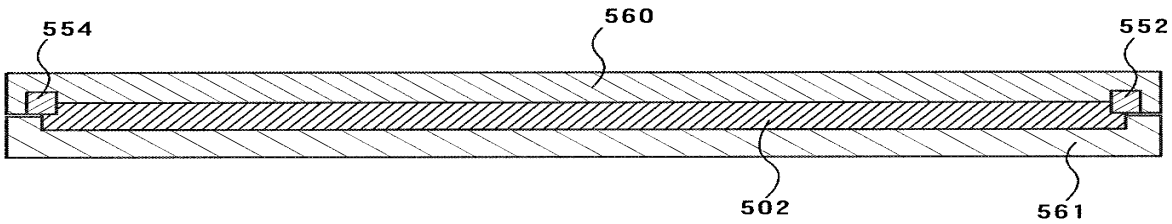


FIG.15C

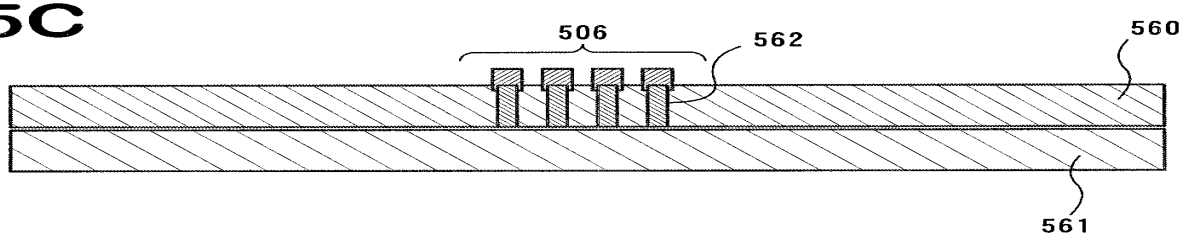


FIG.16A

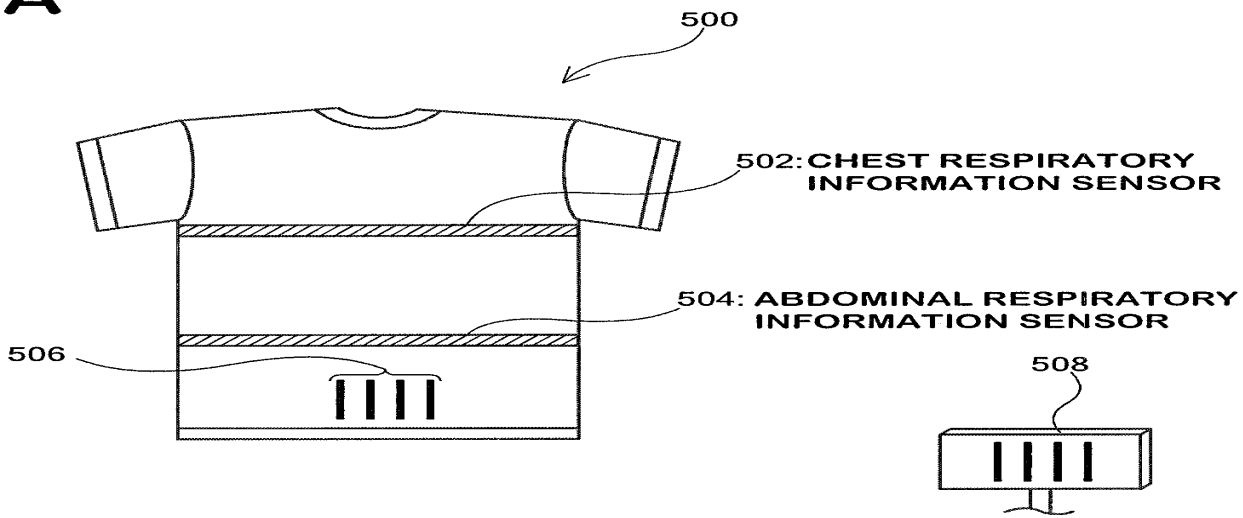


FIG.16B

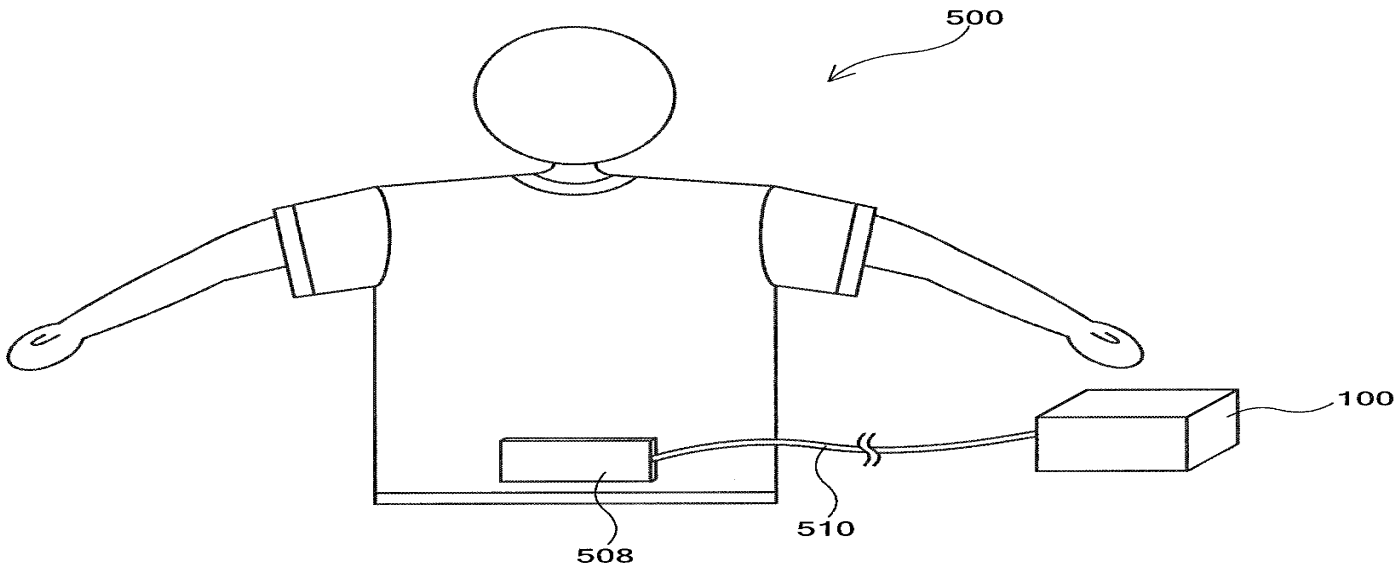


FIG.17

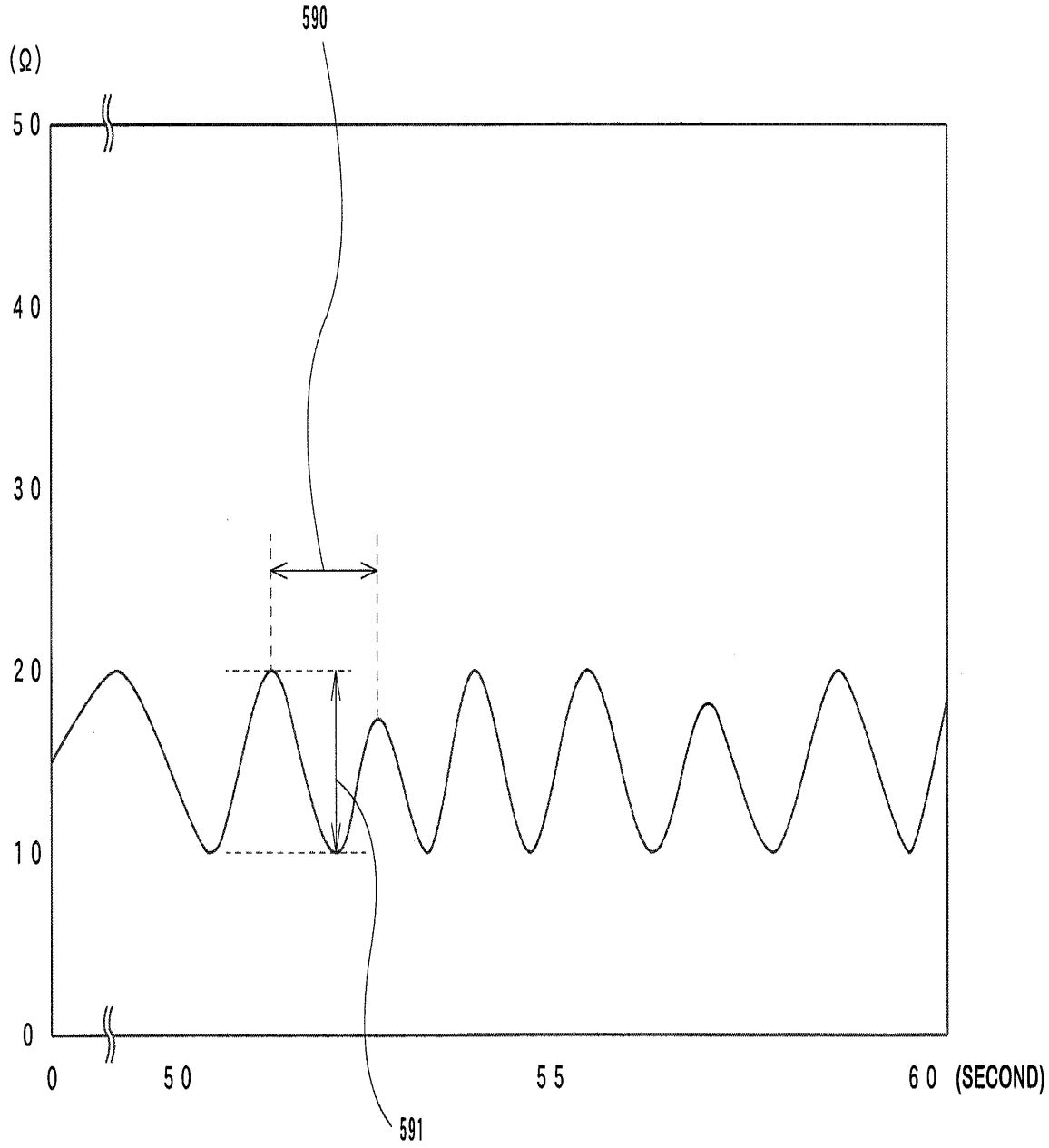


FIG.18

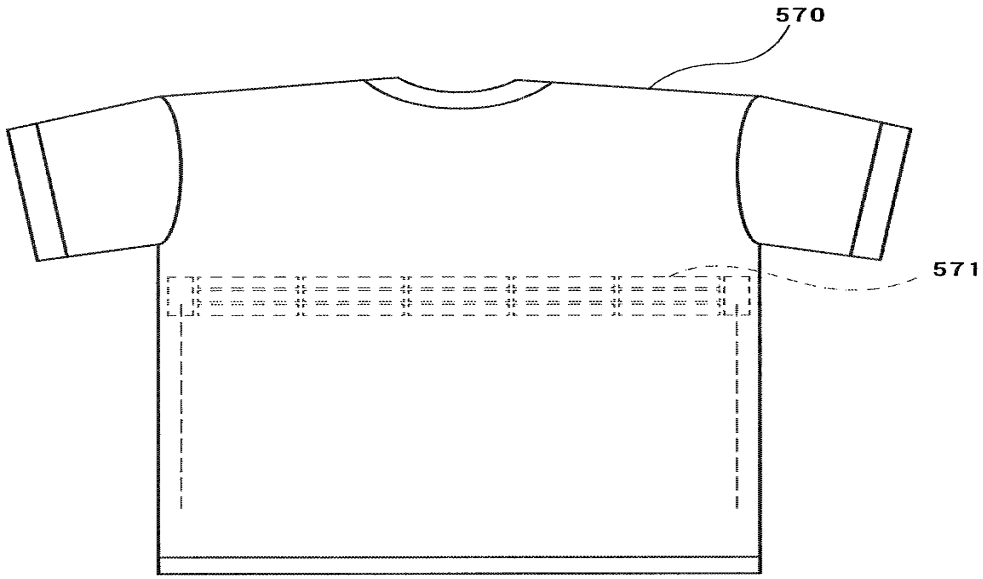


FIG.19A

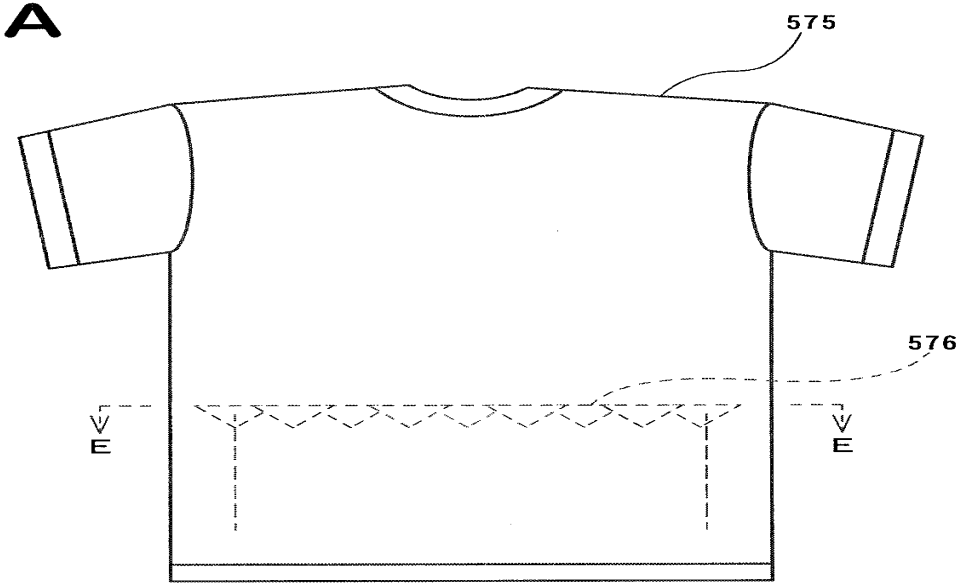


FIG.19B

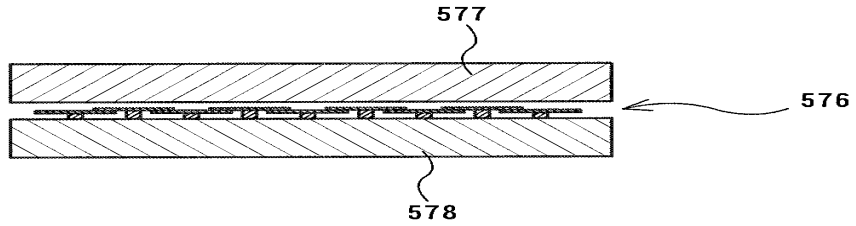


FIG.20

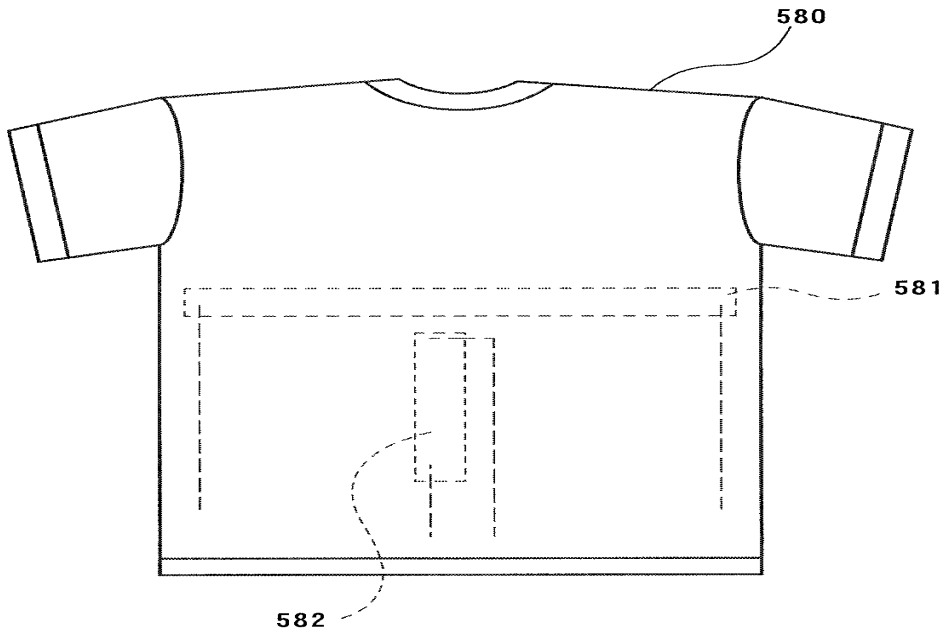


FIG.21

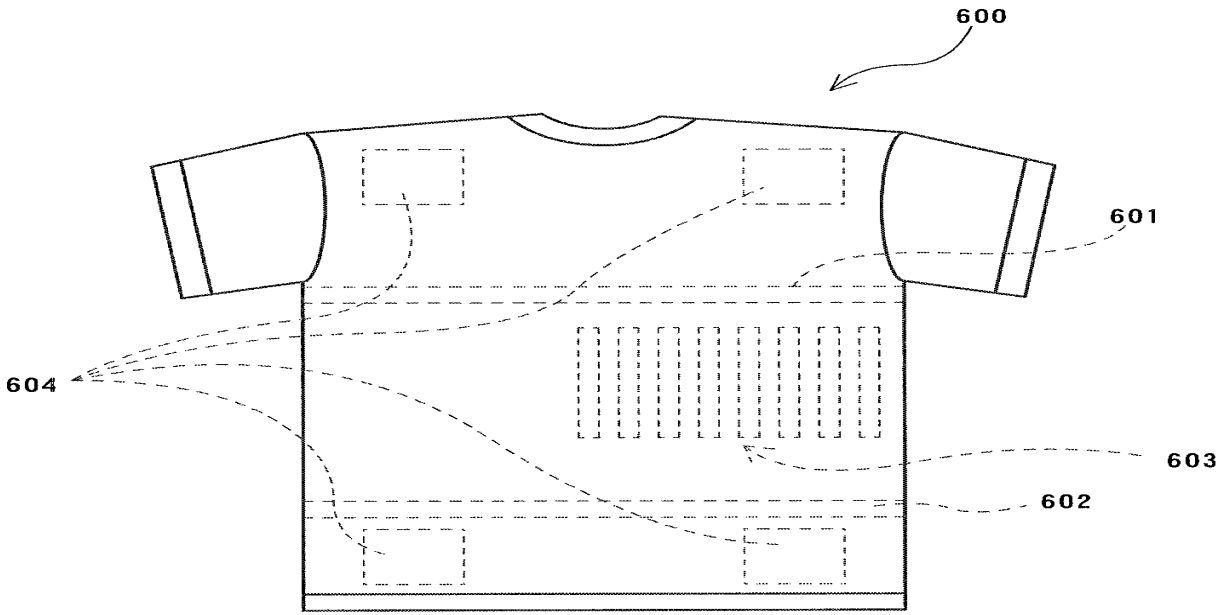


FIG.22

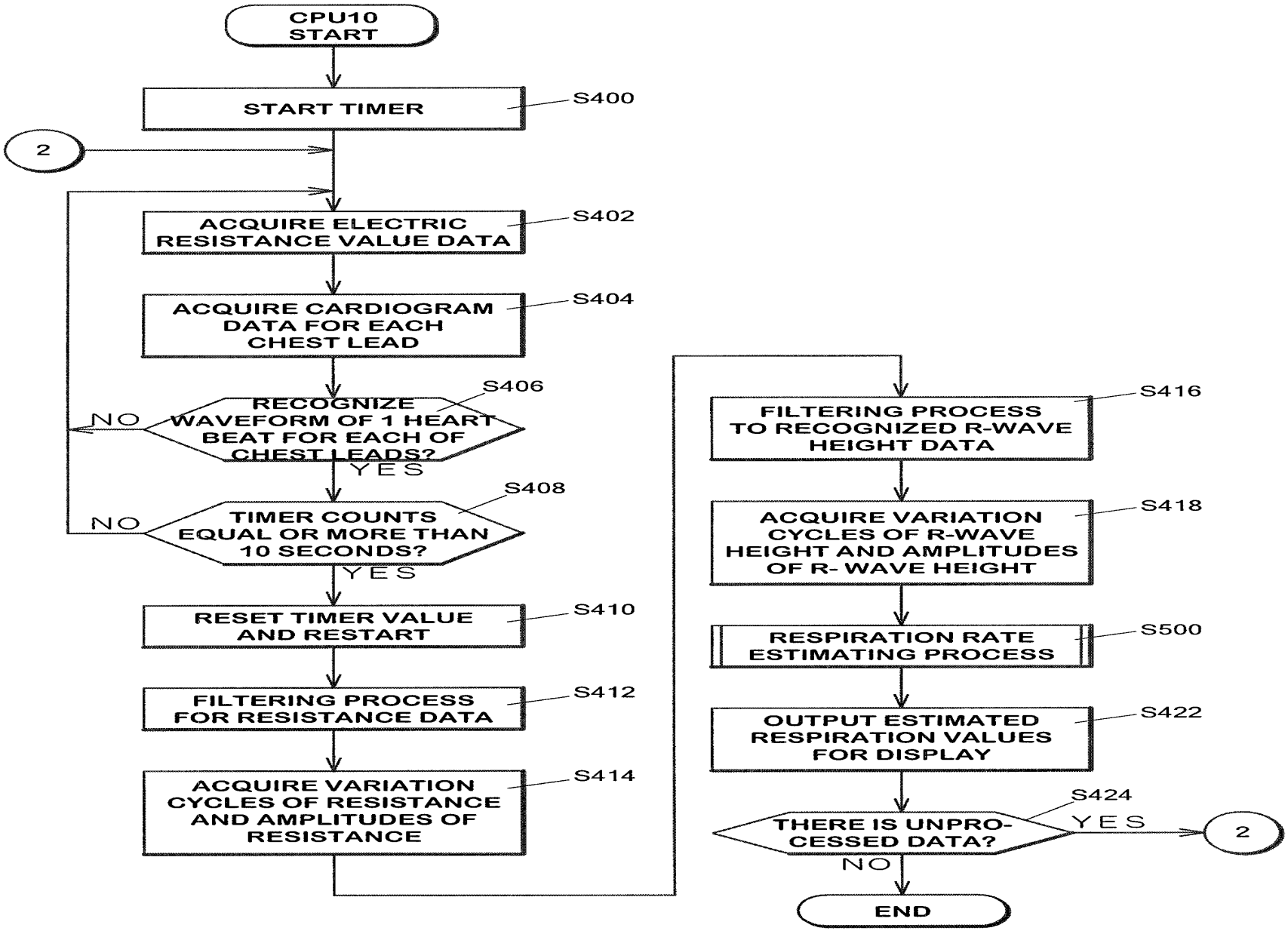

CPU10 START
START TIMER
S400
2
ACQUIRE ELECTRIC RESISTANCE VALUE DATA
S402
ACQUIRE CARDIOGRAM DATA FOR EACH CHEST LEAD
S404
RECOGNIZE WAVEFORM OF 1 HEART BEAT FOR EACH OF CHEST LEADS?
S406
NO
YES
TIMER COUNTS EQUAL OR MORE THAN 10 SECONDS?
S408
NO
YES
RESET TIMER VALUE AND RESTART
S410
FILTERING PROCESS FOR RESISTANCE DATA
S412
ACQUIRE VARIATION CYCLES OF RESISTANCE AND AMPLITUDES OF RESISTANCE
S414
FILTERING PROCESS TO RECOGNIZED R-WAVE HEIGHT DATA
S416
ACQUIRE VARIATION CYCLES OF R-WAVE HEIGHT AND AMPLITUDES OF R- WAVE HEIGHT
S418
RESPIRATION RATE ESTIMATING PROCESS
S500
OUTPUT ESTIMATED RESPIRATION VALUES FOR DISPLAY
S422
THERE IS UNPROCESSED DATA?
S424
YES
2
NO
END

FIG.23

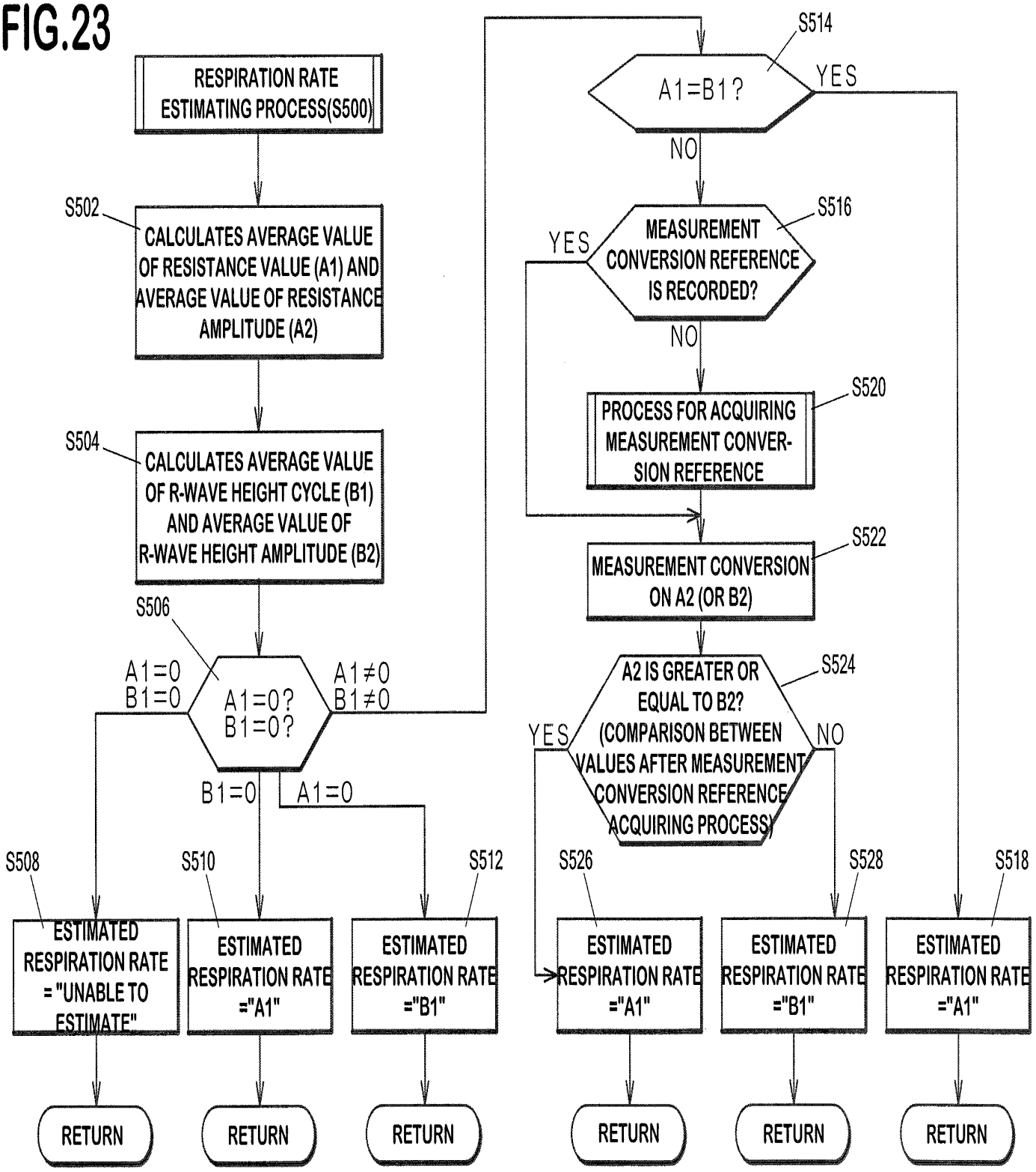

RESPIRATION RATE ESTIMATING PROCESS(S500)
S502
CALCULATES AVERAGE VALUE OF RESISTANCE VALUE (A1) AND AVERAGE VALUE OF RESISTANCE AMPLITUDE (A2)
S504
CALCULATES AVERAGE VALUE OF R-WAVE HEIGHT CYCLE (B1) AND AVERAGE VALUE OF R-WAVE HEIGHT AMPLITUDE (B2)
S506
A1=0 B1=0
A1=0? B1=0?
A1≠0 B1≠0
B1=0
A1=0
S508
ESTIMATED RESPIRATION RATE = "UNABLE TO ESTIMATE"
S510
ESTIMATED RESPIRATION RATE ="A1"
S512
ESTIMATED RESPIRATION RATE ="B1"
RETURN
RETURN
RETURN
S514
A1=B1?
YES
NO
S516
MEASUREMENT CONVERSION REFERENCE IS RECORDED?
YES
NO
S520
PROCESS FOR ACQUIRING MEASUREMENT CONVERSION REFERENCE
S522
MEASUREMENT CONVERSION ON A2 (OR B2)
S524
A2 IS GREATER OR EQUAL TO B2? (COMPARISON BETWEEN VALUES AFTER MEASUREMENT CONVERSION REFERENCE ACQUIRING PROCESS)
YES
NO
S526
ESTIMATED RESPIRATION RATE ="A1"
S528
ESTIMATED RESPIRATION RATE ="B1"
S518
ESTIMATED RESPIRATION RATE ="A1"
RETURN
RETURN
RETURN

FIG.24

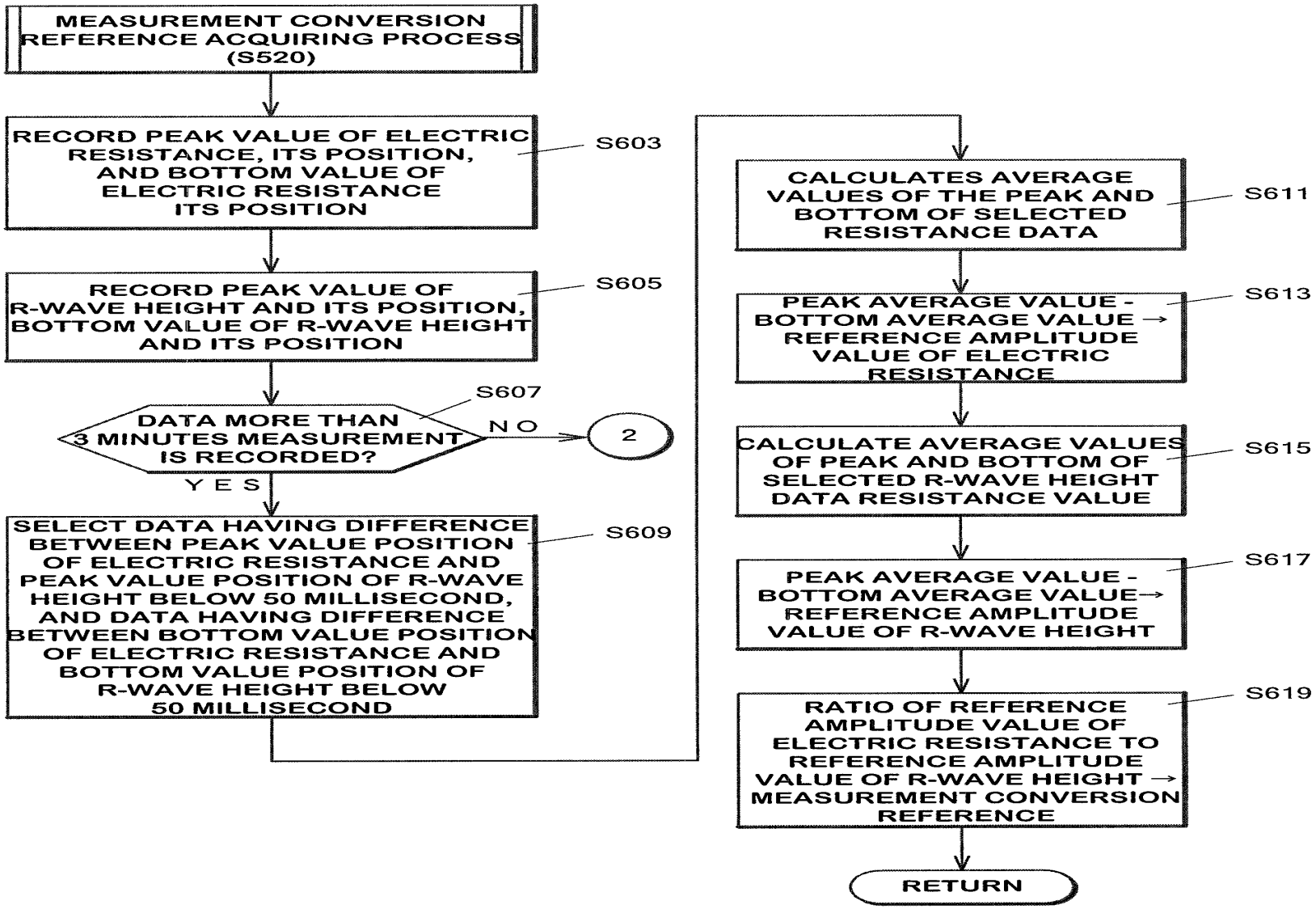

MEASUREMENT CONVERSION REFERENCE ACQUIRING PROCESS (S520)
RECORD PEAK VALUE OF ELECTRIC RESISTANCE, ITS POSITION, AND BOTTOM VALUE OF ELECTRIC RESISTANCE ITS POSITION
S603
RECORD PEAK VALUE OF R-WAVE HEIGHT AND ITS POSITION, BOTTOM VALUE OF R-WAVE HEIGHT AND ITS POSITION
S605
S607
DATA MORE THAN 3 MINUTES MEASUREMENT IS RECORDED?
NO
2
YES
SELECT DATA HAVING DIFFERENCE BETWEEN PEAK VALUE POSITION OF ELECTRIC RESISTANCE AND PEAK VALUE POSITION OF R-WAVE HEIGHT BELOW 50 MILLISECOND, AND DATA HAVING DIFFERENCE BETWEEN BOTTOM VALUE POSITION OF ELECTRIC RESISTANCE AND BOTTOM VALUE POSITION OF R-WAVE HEIGHT BELOW 50 MILLISECOND
S609
CALCULATES AVERAGE VALUES OF THE PEAK AND BOTTOM OF SELECTED RESISTANCE DATA
S611
PEAK AVERAGE VALUE - BOTTOM AVERAGE VALUE → REFERENCE AMPLITUDE VALUE OF ELECTRIC RESISTANCE
S613
CALCULATE AVERAGE VALUES OF PEAK AND BOTTOM OF SELECTED R-WAVE HEIGHT DATA RESISTANCE VALUE
S615
PEAK AVERAGE VALUE - BOTTOM AVERAGE VALUE→ REFERENCE AMPLITUDE VALUE OF R-WAVE HEIGHT
S617
RATIO OF REFERENCE AMPLITUDE VALUE OF ELECTRIC RESISTANCE TO REFERENCE AMPLITUDE VALUE OF R-WAVE HEIGHT → MEASUREMENT CONVERSION REFERENCE
S619
RETURN

FIG.25A

Data No.	RESISTANCE VALUE CYCLE (Hz)	R-WAVE HEIGHT CYCLE (Hz)	RESISTANCE VALUE AMPLITUDE (Ω)	R-WAVE HEIGHT AMPLITUDE (mV)
1801	0.26	0.25	10.70	0.23
1802	0.28	0.24	10.80	0.23
1803	0.25	0.26	10.60	0.24
AVERAGE	0.26	0.25	10.70	0.23

FIG.25B

Data No.	RESISTANCE VALUE AMPLITUDE (Ω)	R-WAVE HEIGHT AMPLITUDE (mV)	R-WAVE HEIGHT AMPLITUDE (Ω) (AFTER MEASUREMENT CONVERSION)
1801-1803			
AVERAGE	10.70	0.23	10.81

FIG.26A

Data No.	PEAK RESISTANCE VALUE (Ω)	PEAK POSITION (sec)	R-WAVE HEIGHT PEAK VALUE(mV)	PEAK POSITION (sec)	BOTTOM RESISTANCE VALUE (Ω)	BOTTOM POSITION (sec)	R-WAVE HEIGHT BOTTOM VALUE (mV)	BOTTOM POSITION (sec)
1501	19.2	2.502	0.70	2.498	7.9	4.402	0.51	4.395
1502	18.9	6.491	0.72	6.391	8.4	8.382	0.52	8.330
1503	19.1	10.380	0.69	10.260	8.2	12.520	0.49	12.460
1504	18.7	14.270	0.72	14.245	7.6	16.100	0.56	16.045
1543	18.9	168.200	0.78	168.180	8.1	170.150	0.52	170.148

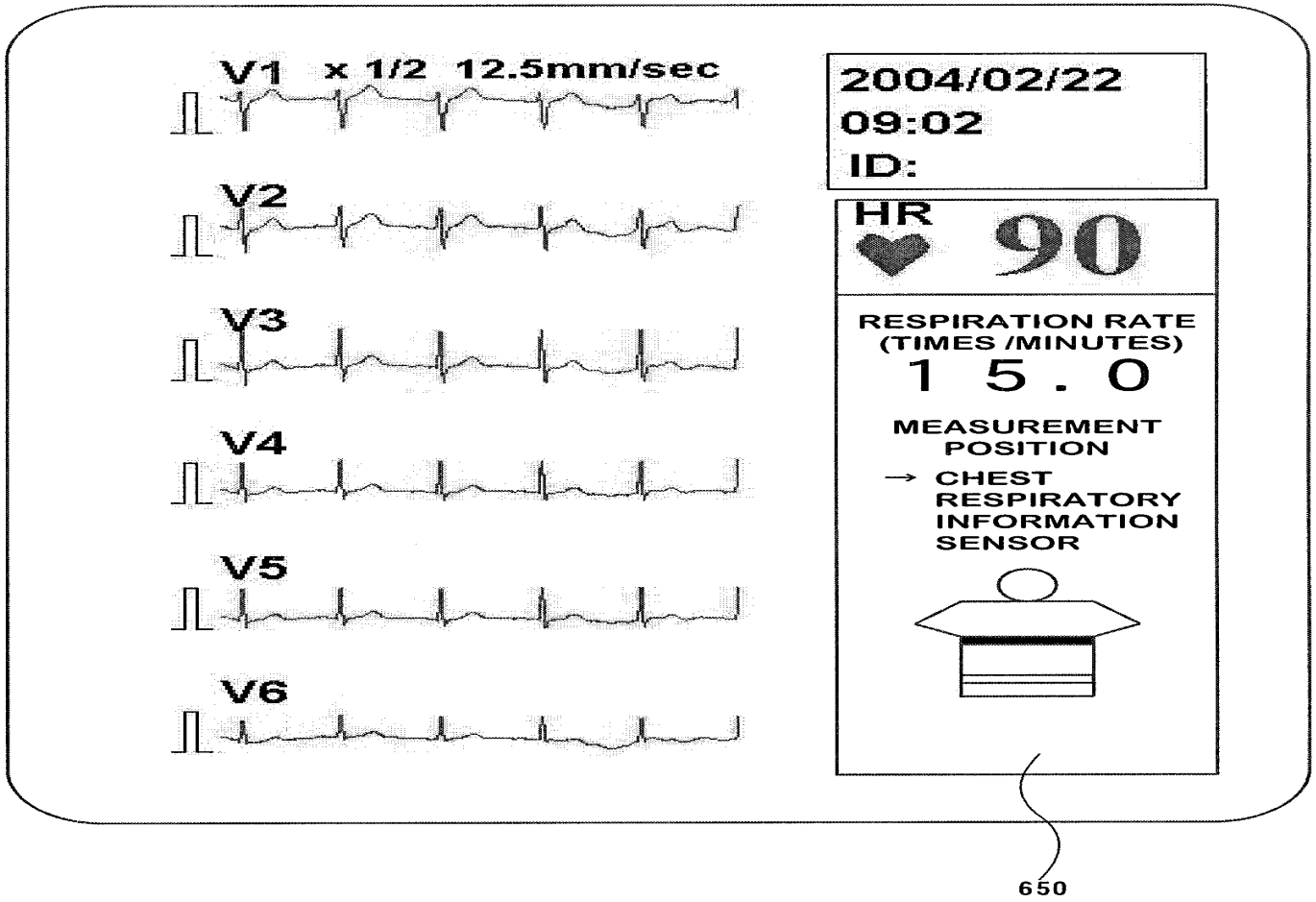
FIG.26B

Data No.	PEAK RESISTANCE VALUE (Ω)	PEAK POSITION (sec)	R-WAVE HEIGHT PEAK VALUE(mV)	PEAK POSITION (sec)	BOTTOM RESISTANCE VALUE (Ω)	BOTTOM POSITION (sec)	R-WAVE HEIGHT BOTTOM VALUE (mV)	BOTTOM POSITION (sec)
1501	19.2	2.502	0.70	2.498	7.9	4.402	0.51	4.395
1543	18.9	168.200	0.78	168.180	8.1	170.150	0.52	170.148
AVERAGE	19.1	–	0.75	–	7.9	–	0.51	–

FIG.26C

Data No.	REFERENCE AMPLITUDE VALUE OF ELECTRIC RESISTANCE (Ω) (X)	REFERENCE AMPLITUDE VALUE OF R-WAVE HEIGHT (mV) (X)	MEASUREMENT CONVERSION REFERENCE (X/Y)
1501-1543	11.2	0.24	47

FIG.27


V1 x 1/2 12.5mm/sec
V2
V3
V4
V5
V6
2004/02/22
09:02
ID:
HR
90
RESPIRATION RATE
(TIMES /MINUTES)
15.0
MEASUREMENT
POSITION
→ CHEST
RESPIRATORY
INFORMATION
SENSOR
650